FOREST PEST LEAFLET 53

# *Western Spruce Budworm*[1]

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The western spruce budworm (*Choristoneura occidentalis* Freeman) is the most widely distributed and destructive forest defoliator in western North America. Until recently, it was considered to be a western form of the spruce budworm (*C. fumiferana* (Clements)). It is found in the Rocky Mountains, from Arizona and New Mexico to the southeast quarter of British Columbia, west to Vancouver Island, and south into Washington and Oregon, with outlying spots in northern California. Its distribution is shown in figure 1.

The first recorded outbreak of this budworm occurred in 1909 on the southeastern part of Vancouver Island in British Columbia. Since that year, infestations of this and related species have frequently been reported in Western Canada.

Although present in Oregon since 1914, the budworm was first recognized as a serious enemy to forests in the Western United States in 1922, when two outbreaks occurred in Idaho. Widespread, destructive epidemics subsequently caused serious growth losses, top-killing, and some tree-killing in pole size and sawtimber stands.

No trend in epidemic behavior has been established. Some of the early budworm epidemics lasted a few years and then subsided from natural causes while others persisted longer but without spreading over large areas. In 1944, an extensive outbreak in Oregon and Wash-

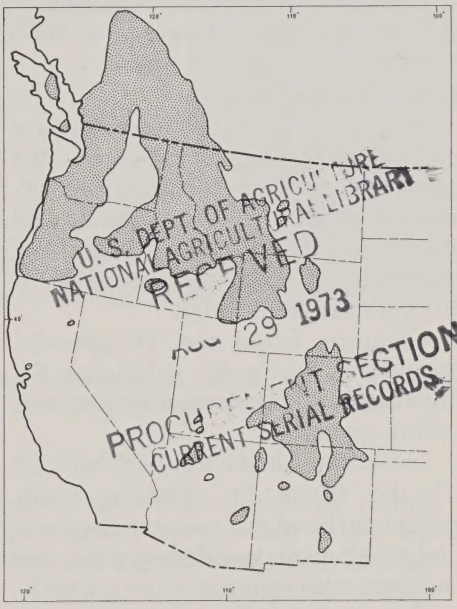


**Figure 1.—Distribution of western spruce budworm.**

[1] The title of FPL53, *Spruce Budworm in the Western United States*, has been changed to *Western Spruce Budworm* for greater clarity and conciseness.

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ington began that lasted for 15 years. This epidemic required an aerial spray program to reduce heavy infestations of the budworm and to prevent the destruction of valuable forest resources. An epidemic in the northern Rocky Mountains, which began in 1949, has now persisted for 22 years; smaller epidemics in the southern and central Rockies were controlled by aerial spraying. In some damaged stands, subsequent tree-killing by bark beetles, mainly the Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopkins), has added to the loss; beetle attacks have sometimes extended into healthy stands.

In recent years, in the northern Rocky Mountains, the budworm has drastically reduced the seed crop of principal tree species and, over much of the Rockies, has become a pest of natural regeneration, causing trees to be deformed. Both types of damage can cause significant delays in establishment of new forests.

## Host Trees

While many coniferous species are fed upon by this budworm, the greatest economic damage has occurred in stands of Douglas-fir and associated true firs. New foliage of host trees is preferred, and trees of all ages are defoliated.

Common hosts are Douglas-fir, grand fir, white fir, subalpine fir, blue spruce, Engelmann spruce, and white spruce.

Occasional hosts are corkbark fir Pacific silver fir, western larch, mountain hemlock, western hemlock, lodgepole pine, ponderosa pine, and western white pine.

Some of these same tree species are attacked by other closely related *Choristoneura* species, whose outbreaks are sometimes simultaneous with those of the western spruce budworm. Hybridization among these budworm species occasionally occurs; its effect on outbreaks is unknown.

## Description

Adult moths (fig. 2A) are about 12 mm. long and have a wingspread of 22 to 28 mm. The gray-brown or orange-brown forewings are marked with bands or streaks, and each usually has a conspicuous white dot on the margin of the wing. Eggs are oval, light green, and about 1.2 mm. long. They are deposited in masses on the undersides of the needles, with individual eggs overlapping like shingles (fig. 2B).

Usually there are six larval instars. Upon hatching, the larvae are green with brown heads. During the next three instars, the larvae (fig. 2C) have black heads and collars and an orange-brown or cinnamon-brown body. In the next-to-last instar, the fifth, the larvae have reddish-brown heads marked with black triangles, a black collar, and a pale olive-brown body, marked with small whitish spots. Full-grown larvae (fig. 2D) are 25 to 32 mm. long, with tan or light chestnut-brown heads and collars, and with large ivory-colored areas superimposed on an olive-brown or reddish-brown body.

Pupae (fig. 2E) are 12 to 16 mm. long, broad at the head end but tapering rapidly toward the tail. They are brownish-yellow or occasionally brownish-green when first formed and later turn reddish-brown.

## Evidence of Infestation

Evidence of infestation varies with the season of the year. In spring, before shoot growth begins, the absence of needles on year-old shoots may indicate feeding activity during the previous year. A search may disclose small larvae mining needles (fig. 3) or the swelling buds (fig. 4), with silken webs

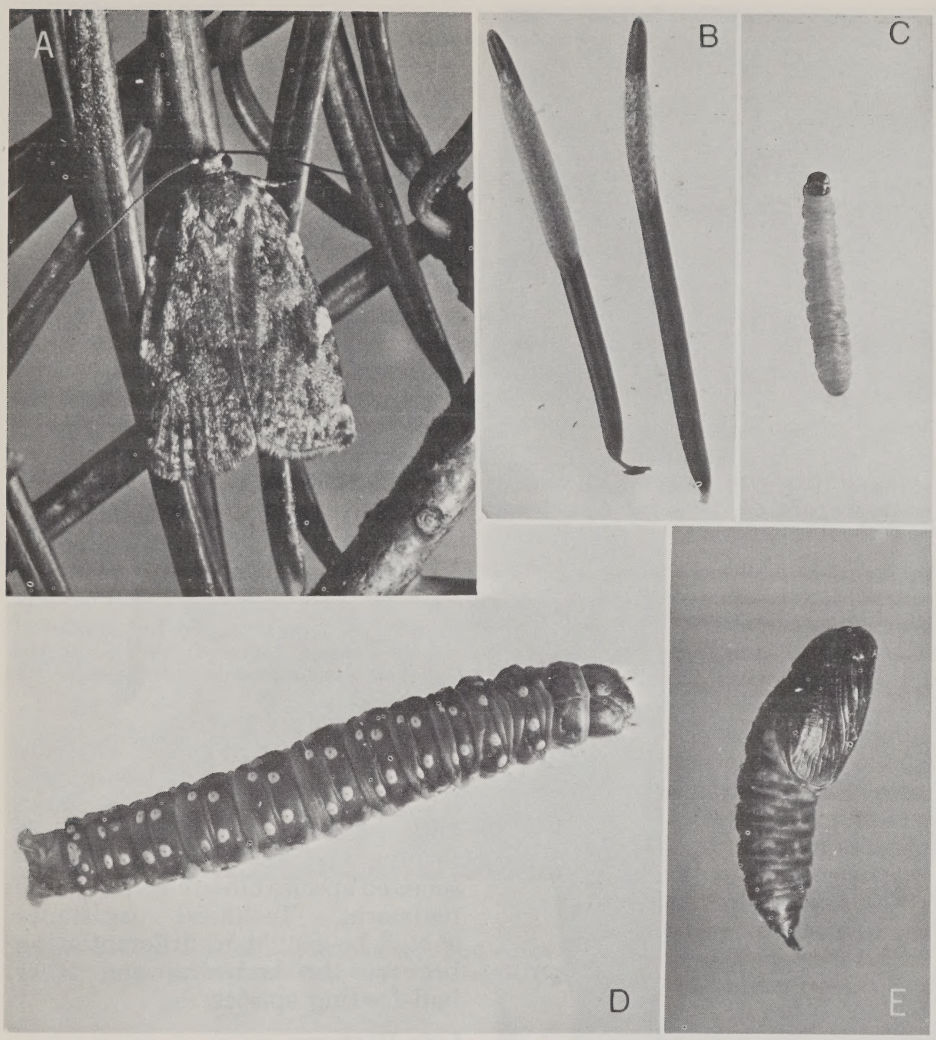


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**Figure 2.—Life stages of the western spruce budworm: A, Adult; B, egg masses C, fourth-instar larva; D, sixth-instar (full-grown) larva (head at right); E pupa. (All 3.2X.)**

at points of entry. As shoot growth starts, adjacent shoots are often webbed together by the budworm larva, and other shoots appear twisted or stunted. In early July, webbed branch tips that turn reddish-brown (fig. 5) indicate the presence of full-grown larvae. When infested stands are viewed from vantage points, the trees appear to have been singed by a light crown fire. The discolored foliage is removed by the fall rains, and bare tips indicate budworm feeding.

During outbreaks, larvae may destroy practically all the new needle growth and a large proportion of buds and new shoots. Young-growth fir stands suffer heavy damage (fig. 6), and understory trees in particular are severely defoliated. After 4 to 5 years of sustained at-

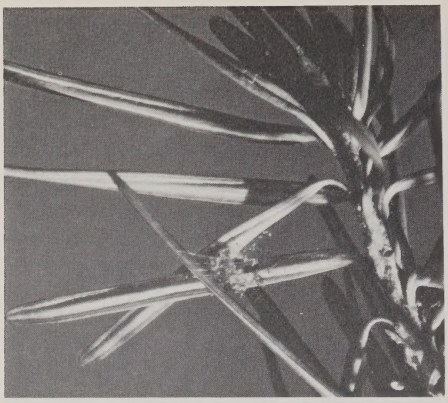

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**Figure 3.—Silken threads and frass around entrance hole made by a western spruce budworm larva during needle-mining period.**

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**Figure 4.—Threads and frass, evidence that a western spruce budworm has entered a swollen bud.**

tack, many trees are almost entirely defoliated, with growth sharply reduced. Some trees begin to die, starting at the top.

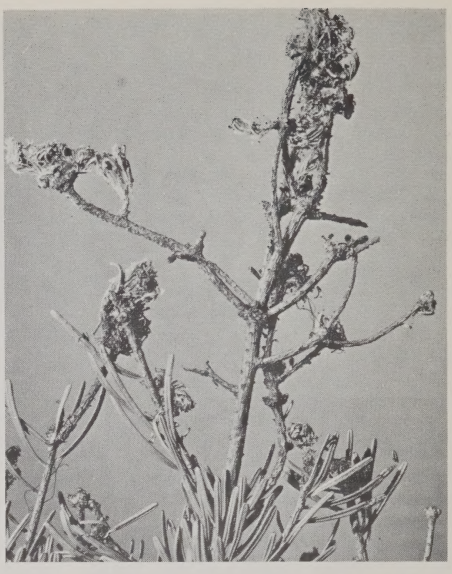

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**Figure 5.—Tips of grand fir defoliated and webbed together by full-grown western spruce budworm larvae.**

Usually one or more species of defoliators, normally of little economic importance, are associated with western spruce budworm. In feeding and appearance, some associated species closely resemble the budworm. Technical assistance should be sought in differentiating between the budworm and other bud-feeding species.

## Life History

The budworm normally develops from egg to adult in 12 months. However, a small proportion of some populations may require 24 months to complete development.

Moths usually emerge from pupal cases late in July or early in August; shortly afterwards the females deposit egg masses. A female lays approximately 150 eggs in masses of a few to 130 eggs; egg masses average 25 to 40 eggs, depending on the forest region. The eggs hatch in about 10 days. The tiny larvae do not feed but seek hiding places among lichens or

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**Figure 6.—Feeding of western spruce budworm on this young-growth Douglas-fir stand has resulted in severe defoliation and some mortality.**

under bark scales on limbs or the bole of host trees. Here they spin silken shelters (hibernacula) in which they remain dormant over winter.

In spring, the larvae move to the foliage where they tunnel into needles and feed for 7 to 14 days. About the time the buds start to swell, larvae leave the needles and bore into the expanding buds. Sometimes they move directly from hibernation to the vegetative buds or male and female flowers. As new shoots unfurl, the larvae spin loose webs between the needles and tips. Within the webs, they feed on new foliage which is entirely destroyed before they feed on older needles. Larvae become full-grown in 30 to 40 days after attacking the buds. They change to pupae either in existing webs or webs they spin other places on the tree.

Adult moths are sluggish fliers but may be carried great distances by air currents, thus spreading the infestation. Normally the female deposits its eggs within 7 to 10 days after emergence and dies.

Feeding habits may vary with the tree host and region. In most regions, large larvae on Douglas-fir and true firs feed on new foliage,

even though their earlier feeding may have included staminate flowers and conelets. However, in the northern Rocky Mountains, large larvae often feed on cones and seeds of western larch and Douglas-fir, then pupate in cones.

## Natural Control

Budworm populations normally are held in check by combinations of several natural control factors, such as parasites, predators, and adverse climatic conditions. However, when climatic conditions are favorable for an increase in budworm populations (decreased numbers of low pressure centers, early and dry growing seasons), the combined effect of other natural factors cannot be relied upon to prevent an outbreak. During prolonged outbreaks, starvation can be an important factor in controlling budworm populations.

Approximately 40 species of primary parasites (small wasps and flies) have been found attacking the budworm, with some 10 to 12 species exerting the most control. Two common parasites are shown in figures 7 and 8.

Spiders, ants, snakeflies, true bugs, and larvae of certain beetles are important predators of the budworm. Warblers, thrushes, sparrows, cedar waxwings, and evening grosbeaks are the more important birds feeding on the budworm.

Budworm mortality from disease has been very low, even though the budworm has been found infected by several pathogens.

Climatic conditions may adversely affect the budworm in several ways. Cool summer weather retards feeding and insect development; occasionally budworm eggs fail to hatch before the onset of freezing temperatures. Extreme temperature changes presumably have a detrimental effect on hibernating larvae, and sudden freezing temperatures in spring may kill larvae in needles, buds, or new shoots. Windy conditions at the time larvae hatch from eggs or are leaving hibernation quarters may disperse these larvae over wide areas. Pre-

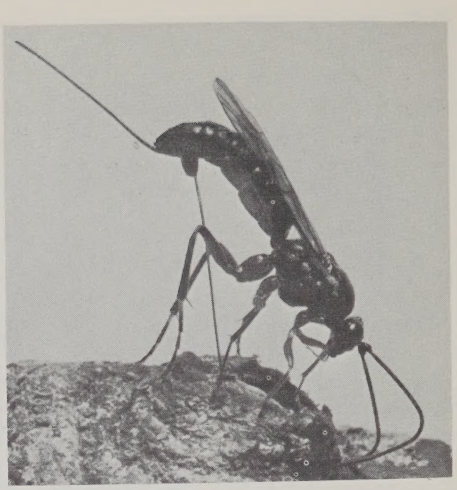

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**Figure 7.—Adult of the parasite *Glypta fumiferanae* Viereck) ovipositing in body of overwintering western spruce budworm larva, concealed within twig scar.**

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**Figure 8.—Full-grown larva of an external parasite, *Phytodietus fumiferanae* Rohwer, completing its feeding by killing its host, a sixth-instar western spruce budworm larva.**

vailing winds and frontal disturbances can also disperse moths over a wide area.

### Applied Control

Little research has been done on control of the western spruce budworm through forest management practices. Because the budworm attacks trees of all age classes and because the preferred tree species are closely intermingled, little hope is held for such methods of control.

Under forest conditions, direct control of budworm populations can be obtained by aerial application of 95-percent technical grade Malathion (undiluted) at a rate of 13 fluid ounces per acre, using special nozzles for low-volume application. Spray is generally applied when 90 percent of the larvae are in fourth and fifth instars. When application is made during calm and cool morning hours, approximately 90 percent of the budworms are killed. Spraying from large planes results in better spray coverage of continuous forest types than spraying from small planes. At recommended application rates, spraying has caused no deleterious effects on warmblooded animals or fish and only minor and temporary effects on aquatic insects.

Another insecticide, Zectran, has recently been registered for use against western spruce budworm. The recommended spray mixture is 1 gallon of Zectran FS 15 diluted in 9 gallons of deodorized kerosene or similar oil. Another mixture is 3 gallons of Zectran FS 5 diluted in 7 gallons of deodorized kerosene or similar oil. Either spray is aerially applied at the rate of 1 gallon of mixture per acre. Zectran is registered for use by or under the supervision of the USDA Forest Service to control spruce budworm. Therefore the Forest Service should be consulted for further details on recommended procedures in formulating and applying Zectran.

The question of whether to apply direct control measures against the budworm should be decided only after careful consideration of (1) the current effectiveness of natural control, (2) the amount and nature of damage caused and expected to occur, and (3) the forest resources values—economic, esthetic, and recreational—at stake. Some outbreaks are curbed by natural control factors before serious damage occurs; others continue to expand and cause widespread damage. Prediction of the expected course of each outbreak is an essential part of control planning.

***Caution:*** Pesticides used improperly or carelessly can be injurious to man, animals, and some plants. Follow the directions and heed all precautions on the labels.

Apply pesticide so as to avoid direct exposure of humans, livestock, crops, beneficial insects, fish, and wildlife to the spray. Do not apply pesticide when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or when it may contaminate water or leave unnecessary residues. Heed the following guidelines for general pesticide use.

Store pesticides in original containers under lock and key—out of reach of children and animals—and away from food and feed.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, wash before eating or drinking. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides. Dispose of empty pesticide containers promptly. Have them buried at a sanitary landfill dump, or crush and bury them in a level, isolated place.

***Warning:*** Recommendations for use of pesticides are reviewed regularly. The registrations on all suggested uses of pesticides in this publication were in effect at press time. Check with your county agricultural agent, State agricultural experiment station, or local forester to determine if these recommendations are still current.

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